REMARKS/ARGUMENTS

The action by the Examiner of this application, together with the cited references, has been given careful consideration. Following such consideration, claim 1 has been amended to define more clearly the patentable invention applicants believe is disclosed herein. Moreover, claims 9 and 10 have been added. Claims 2-8 are unchanged by the present amendment paper. It is respectfully requested that the Examiner reconsider the claims in their present form, together with the following comments, and allow the application.

The Examiner has rejected claims 1-8 as being obvious in view of the combined teachings of U.S. Patent No. 6,724,133 to Miyashita et al., U.S. Patent No. 3,753,795 to Weber, and U.S. Patent No. 6,470,845 to Kanao. It is respectfully submitted that none of the cited references, taken individually or in combination, teaches or suggests the applicant's invention as defined by the present claims.

The Examiner acknowledges that Miyashita et al. '133 does not disclose a spark plug wherein the nickel alloy contains *aluminum* as a secondary component in an amount of 0.2 wt.% to 0.8 wt.%, as defined by independent claim 1. Accordingly, the Examiner relies upon Weber '795 for disclosing this element of the claimed invention. The Examiner argues that "[i]t would have been obvious to one of ordinary skill in the art at the time the invention was made to incorporate the Al content of the Ni alloy disclosed in Weber into the spark plug of Miyashita et al., as the stability of the resulting aluminum oxide helps to prevent damage to the interior of the electrode." The applicant respectfully submits that the combination of Miyashita et al. '133 with a single element (i.e., aluminum) of the spark plug disclosed by Weber '795 would not have been obvious to one of ordinary skill in the art in view of the cited references.

With reference to the applicant's invention, it is known that when a spark plug for use in an internal combustion engine is used for a long period of time in a low-temperature environment, the spark plug assumes a so-called "carbon fouling" or "fuel fouling" condition, wherein the surface of a distal end portion of the insulator is covered with an electrically conductive fouling substance such as carbon. This makes the spark plug prone to defective operation.

Semi-creeping-discharge spark plugs have a creeping discharge along the surface of a distal end portion of an insulator that burns off the fouling substance. Accordingly, semi-creeping-discharge spark plugs exhibit excellent fouling resistance. However, frequent occurrence of creeping discharge along the surface of a distal end portion of the insulator, causes the surface of the distal end portion of the insulator to be ablated, thus forming a channel on the insulator. This process is referred to as *channeling*. Channeling can result in impairment in heat resistance or reliability of the spark plug.

To suppress channeling of the insulator, a Ni alloy that contains Fe and Cr as secondary components has been used to form a center electrode. Spark erosion of the center electrode associated with spark discharge involves sputtering of Fe and Cr. The sputtered Fe and Cr adhere to the surface of the distal end portion of the insulator, forming a coating layer consisting of oxide semiconductors. Since the oxides form semiconductors, the coating layer is *electrically conductive*. The coating layer protects the insulator and reduces the discharge voltage, thereby *suppressing channeling of the insulator*.

The problem with suppressing channeling by adding a Ni alloy that contains Fe and Cr is that the thermal conductivity of the center electrode decreases as the amount of added Fe and Cr increases. As the thermal conductivity of the center electrode decreases, erosion of the center electrode will increase. Thus, an increase in the amount of added Fe and Cr accelerates erosion of the center electrode.

In accordance with the present invention, Al is added as a secondary component of the Ni alloy to prevent the reduction in thermal conductivity caused by the Fe and Cr content of the Ni alloy. However, Al has not been previously considered as an additional component of the Ni alloy because the oxide of Al (Al_2O_3) that is formed as part of the coating layer on the insulator is electrically insulative, and thus as the oxide forms on the insulator as part of the coating layer it *reduces the electrical conductivity of the coating layer*. As indicated above, maintaining the *electrical conductivity* of the coating layer is important to suppressing *channeling* of the insulator.

It has been recognized by the inventors of the present invention that, despite the problem discussed above, Al can be advantageously used as a secondary component of the Ni alloy to prevent reduction in thermal conductivity of the center electrode caused by the Fe and Cr

in the Ni alloy. In this regard, it has been determined that by limiting the Al content of the Ni alloy to a range in an amount of 0.2 wt.% to 0.8 wt.%, the following can be achieved: (1) reduction in thermal conductivity of the center electrode (caused by the Fe and Cr in the Ni alloy) can be prevented, and (2) by limiting the amount of electrically insulative oxide (Al_2O_3) in the coating layer formed on the insulator the reduction in the electrical conductivity of the coating layer is minimized.

Turning now to U.S. Patent No. 3,753,795 to Weber. The Examiner has relied upon this reference for disclosing a spark plug made of an Ni alloy containing Al as a secondary component in an amount of 0.2 wt.% to 0.8 wt.%. Weber '795 discloses dispersion-strengthened nickel alloy compositions containing: aluminum, chromium, titanium, carbon, a metal from the group consisting of yttrium and Rare Earth metals; and finely divided, well-distributed dispersoid oxide from the group consisting of yttria, Rare Earth oxides, ceria, and thoria (see column 2, lines 24 *et. seq.*). The composition is prepared by mechanical alloying to provide hard dense composite powders. Once the powder is produced it is converted into wire by hot compacting, for example, by hot extrusion, followed by high reduction. The aluminum and chromium of the alloys provide *oxidation resistance*, including cyclic oxidation resistance. The amounts of the aluminum and chromium are correlated to the amount of dispersoid employed so as to insure *drawability of the alloy* (see column 4, lines 13 *et seq.*).

It is respectfully submitted that it would not have been obvious to one of ordinary skill in the art to take the Al used in Weber's Ni alloy and use it in the Ni alloy used to produce the electrode taught by Miyashita et al. '133. In this regard, Weber's Ni alloy material does not include Fe, whereas Miyashita et al. '133 discloses a Ni alloy that does include Fe.

Furthermore, neither Weber '795 nor Miyashita et al. '133 teaches or suggests the use of Al in combination with Fe and Cr, as required by the claimed invention. It is the claimed combination of Fe, Cr, and Al that provides the advantageous results of the present invention, as discussed in detail above. In particular, the Ni alloy having the claimed amount of Fe, Cr, and Al provides the advantageous *anti-channeling* effect of the insulator. The advantageous *anti-channeling* effect of the present invention is not obtained with the Ni alloy taught by Miyashita et al. '133 or Weber '795. Neither reference teaches or suggests a Ni alloy having Fe, Cr, and Al.

The Al is used in the Ni alloy of Weber '795 for the purpose of increasing *drawability*. In contrast, the Al is used in the Ni alloy of the claimed invention to allow the Ni alloy to *suppress channeling of the insulator*, while also preventing a reduction in thermal conductivity of the center electrode caused by the Fe and Cr in the Ni alloy.

It is respectfully submitted that there is no teaching or suggestion that would motivate one skilled in the art to simply take the aluminum used in the spark plug electrode material of Weber '795 and combine it with the other electrode components taught by Miyashita et al. '133. It is submitted that only with the claimed invention as a guide that one skilled in the art would take a single element from Weber's electrode material (i.e., aluminum) and combine it with different elements of a second electrode material.

It is further submitted that Kanao '845 also does not provide for the deficiencies of Miyashita et al. '133.

In view of the foregoing, it is respectfully submitted that claim 1, as well as the remaining claims that depend therefrom (i.e., claims 2-10), are patentable over the cited references for at least the reasons discussed above.

The cited references made of record and not relied upon have also been reviewed. It is respectfully submitted that none of these additional references teaches or suggests the applicant's invention as defined by the present claims.

In view of the foregoing, it is respectfully submitted that the present application is now in proper condition for allowance. If the Examiner believes there are any further matters that need to be discussed in order to expedite the prosecution of the present application, the Examiner is invited to contact the undersigned.

If there are any fees necessitated by the foregoing communication, please charge such fees to our Deposit Account No. 50-0537, referencing our Docket No. NG8775US.

Respectfully submitted,

Date: **June 2, 2005**

Michael A. Jaffe
Registration No. 36,326

Kusner & Jaffe
Highland Place – Suite 310
6151 Wilson Mills Road
Highland Heights, Ohio 44143
(440) 684-1090 (phone)
(440) 684-1095 (fax)

CERTIFICATE OF MAILING UNDER 37 C.F.R. §1.8

I hereby certify that this correspondence (along with any paper referenced as being attached or enclosed) is being deposited on the below date with the United States Postal Service with sufficient postage as first class mail in an envelope addressed to Mail Stop Amendment, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

Date: **June 2, 2005**

Name: Laura K. Cahill